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USERS MANUAL FOR THE ANTENNA PATTERN DISTORTION COMPUTER PROGRA--ETC(U)
JAN 79 J PERINI, S WANG, K HIRASAWA F30602-75-C-0121
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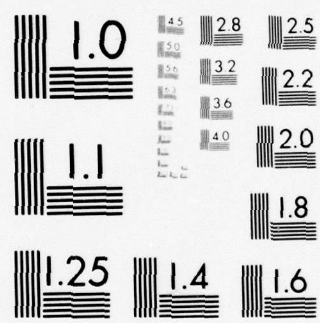

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a step-by-step guide to the user of the Antenna Pattern Distortion Computer Program (DISTORT) which has been developed to analyze the coupling effects, the radiation pattern distortion, and the communication range of antennas mounted in close proximity. The program has been specially designed to analyze the installation of ground-to-air communication stations used by the Air Force. The program is written in a user oriented fashion making it extremely simple to use.

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PREFACE

This effort was conducted by Syracuse University under the sponsorship of the Rome Air Development Center Post-Doctoral Program for Rome Air Development Center. Mr. Marvin Hirshman (EEIT) and Capt. Jerry Rintella (EEIMC), 1842 EEG, were the task project engineers and provided overall technical direction and guidance.

The RADC Post-Doctoral Program is a cooperative venture between RADC and some sixty-five universities eligible to participate in the program. Syracuse University (Department of Electrical Engineering), Purdue University (School of Electrical Engineering), Georgia Institute of Technology (School of Electrical Engineering), and State University of New York at Buffalo (Department of Electrical Engineering) act as prime contractor schools with other schools participating via sub-contracts with prime schools. The U.S. Air Force Academy (Department of Electrical Engineering), Air Force Institute of Technology (Department of Electrical Engineering), and the Naval Post Graduate School (Department of Electrical Engineering) also participate in the program.

The Post-Doctoral Program provides an opportunit for faculty at participating universities to spend up to one year full time on exploratory development and problem-solving efforts with the post-doctorals splitting their time between the customer location and their educational institutions. The program is totally customer-funded with current projects being undertaken for Rome Air Development Center (RADC), Space and Missile Systems Organization (SAMSO), Aeronautical System Division (ASD), Electronics Systems Division (ESD), Air Force Avionics Laboratory (AFAL), Foreign Technology Division (FTD), Air Force Weapons Laboratory (AFWL), Armament Development and Test Center (ADTC), Air Force Communications Service (AFCS), Aerospace Defense Command (ADC), HQ USAF, Defense Communications Agency (DCA), Navy, Army, Aerospace Medical Division (AMD), and Federal Aviation Administration (FAA).

Further information about the RADC Post-Doctoral Program can be obtained from Mr. Jacob Scherer, RADC/RBC, Griffiss AFB, NY, 13441, telephone Autovon 587-2543, Commercial (315) 330-2543.

TABLE OF CONTENTS

1. GENERAL DESCRIPTION

1.1 Purpose of the Users Manual

The objective of the Users Manual for the ANTENNA PATTERN DISTORTION COMPUTER PROGRAM - VERSION IV is to provide the user with the information necessary to effectively use the system.

1.2 References

a. Previous documentation Antenna Pattern Distortion Computer Program, RADC-TR-75-146, May 1975.

b. Computer Program Maintenance Manual for the Antenna Pattern Distortion Computer Program - Version IV.

c. USERS MANUAL FOR THE SCREEN SYSTEM (DSD M057, March 1976).

2. SYSTEM SUMMARY

2.1 System Application

The ANTENNA PATTERN DISTORTION COMPUTER PROGRAM calculates antenna coupling coefficients, vertical and horizontal radiation patterns, communication range contours and pattern distributions of antenna farms such as those found in many AF air-to-ground communication installations.

2.2 System Configuration

2.2.1. Computer. Honeywell 6060, GCOS SRH.2 and HP 7202A Graphic Plotter.

2.2.2 Input/Output Devices. (a) On-line disks

(b) Terminal

Keyboard
Printer
Plotter

2.3 System Organization (Details see Section 2 of the Computer Program Maintenance Manual)

The system consists of three subsystems.

a. Subsystem /RADIO/DISTORT

b. Subsystem /RADIO/USA

c. Subsystem /RADIO/DISTORTP

d. Utility Packages.

2.4 General Description of Input, Processing Output

1. /RADIO/DISTORT and /RADIO/DISTORTP have been compiled and stored in files with these names in the user library so that they can be called directly in response to the "SYSTEM?" question. /RADIO/DISTORT accepts as input the necessary information about the physical location of the antennas in the antenna farm and performs all the desired calculations. /RADIO/DISTORTP plots this information on the HP 7202A plotter.

2. Input data requested by the System /RADIO/DISTORT

   (a) Antenna types and locations - entered by the user (See examples in Section 3).

   (b) Communication installation topographical data - obtained from the DATAFILE which has been created by the SCREEN program.

   (c) Communication site parameters - entered by the user.

3. The output of /RADIO/DISTORT is stored in file /DISTRT/XXXX for future use by /RADIO/DISTORTP. XXXX is a four digit number automatically assigned by the computer. A hard copy of the output is also available from the highspeed printer at the central site.

4. Input data requested by the System /RADIO/DISTORTP to plot radiation patterns.

   a. The data to be plotted is stored in file /DISTRT/XXXX

   b. The user will have to answer questions about the format of the plots asked by /RADIO/DISTORTP

2.2 Instructions on Accessing the System

2.5.1 General

   a. Follow the established log-on procedure.

   b. Computer request for user input is indicated by a "=" on left most position of a line; user should enter required data in the order indicated and follow the data by a carriage return. Separate the fields by commas.

2.5.2 Accessing Subsystem /RADIO/DISTORT (For sample runs see Section 3)

   a. In response to "SYSTEM?" type
      FORT NEW

   b. The computer will print
      READY
      *

   c. Type RUN AFCS.LIB/RADIO/DISTORT

   d. The program will then start asking questions.

      [1] Antenna Positions

A system of rectangular coordinates x, y, z will be used for specifying the position of the antennas in the installation as shown in Figures 1 and 2. The vertical axis is always z and the x,y axis defines a reference plane which must coincide with the installation ground plane if there is one. In this case the z_i are the heights of the base of each antenna above the ground plane. In cases where no ground plane is used, the axis x,y define an arbitrary reference plane and the z_i are the heights of

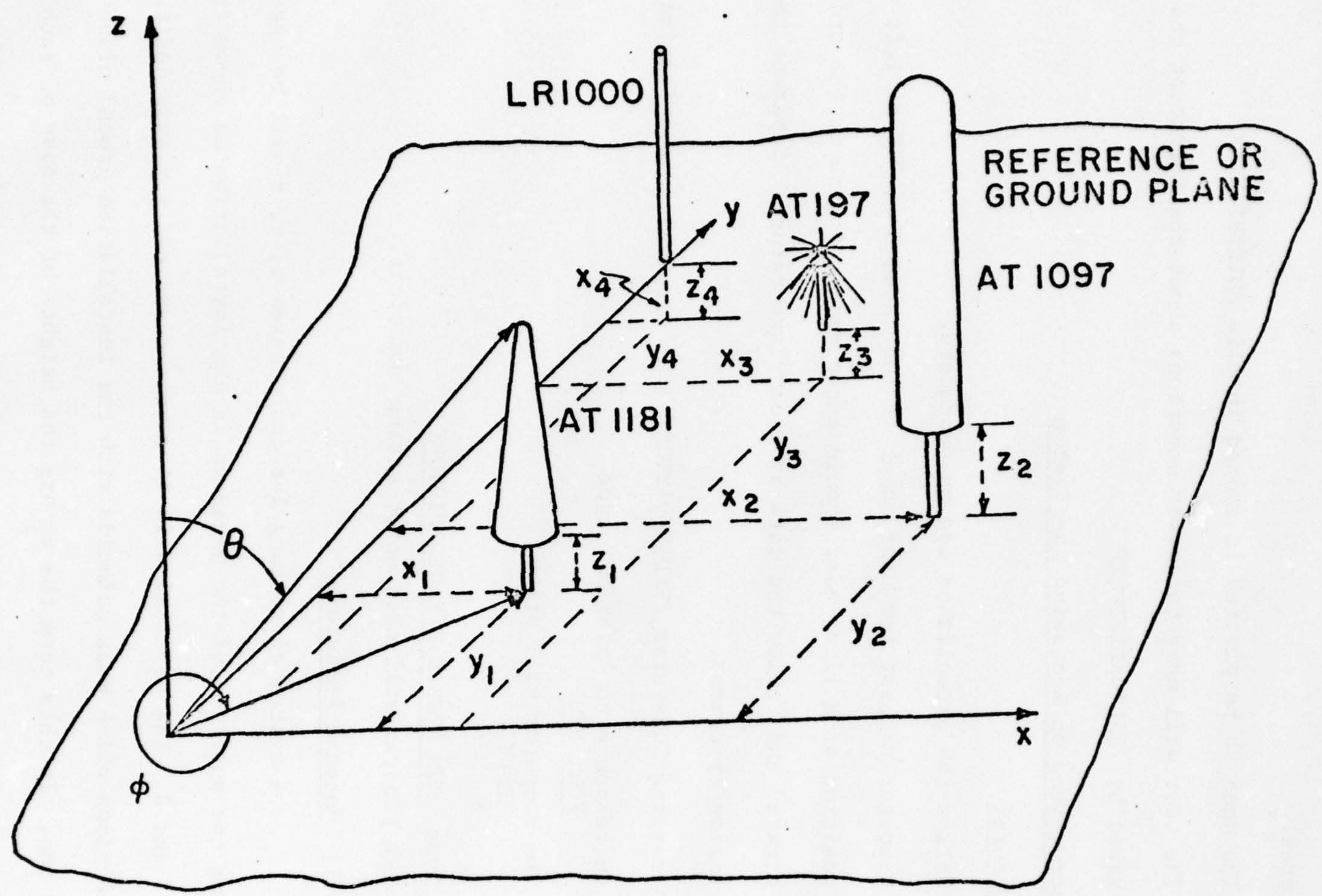


Figure 1 - Geometry and Parameters of the Simplified Program

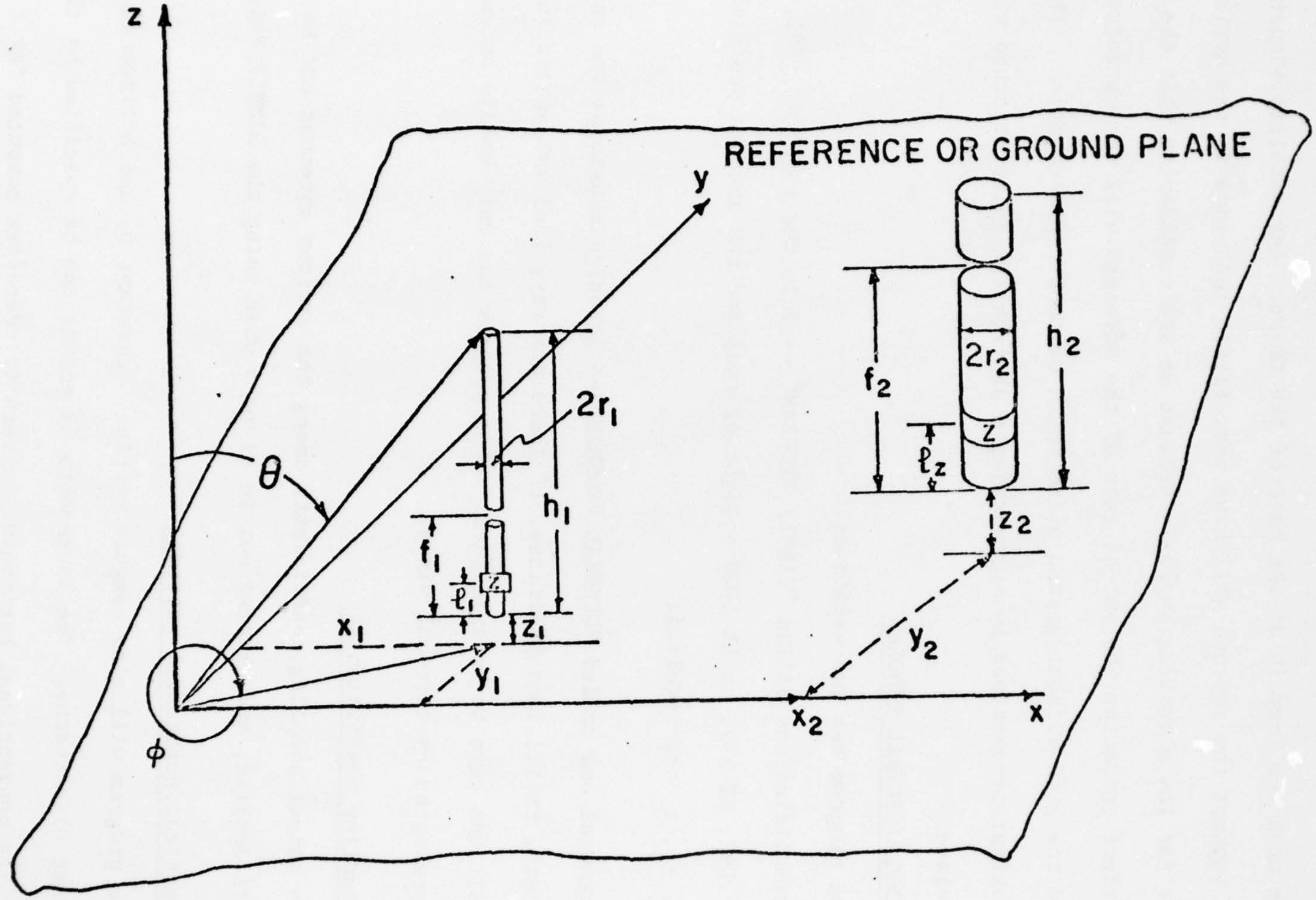


Figure 2 - Geometry and Parameters of the General Program

the base of each antenna above this plane. When we refer to a ground plane here, we mean the terrain at the base of the tower. Any metallic structure used to support the antenna will have very little influence in the horizontal patterns for low elevation angles. Because we are considering that the ground is a perfect conductor the actual gain of the antennas will not be quite correct and the gain without ground plane would be more representative. This can be approximately obtained by subtracting 6 dB from the gains obtained with ground plane.

[2] SIMPLE/GENERAL PROGRAM

The program has two versions:

1. A simplified one called "SIMPLE PROGRAM" -- only the type (AT 1181, AT 1097, AT 197, or LR 1000 - lighting rod) and the antenna positions x_i, y_i, z_i are required.

2. A general one called "GENERAL PROGRAM" -- actual dimensions: the antenna length, radii, load positions, if there are any, load values and feed positions have to be specified. This program can only handle antennas represented by vertical wires.

[3] Coupling coefficients

The mutual coupling coefficients among the various antennas can be computed if desired, and printed out in dB only when using the SIMPLE PROGRAM.

[4] Vertical/Horizontal patterns

The program will also compute vertical (constant ϕ) and horizontal (constant θ) patterns. The increments $\Delta\theta$ and $\Delta\phi$ can be specified by the user. The conventional horizontal pattern is therefore computed for $\theta = 90°$, the horizontal plane, but if desired, any polar angle θ can be specified.

When patterns are computed, the output will be in normalized magnitude expressed in ratio, NMAG and in dB, NMAG(DB). The value of the field used for the normalization is printed under EMAX. The gain of the antenna over the isotropic source and in the direction of EMAX is also printed as a ratio, GAIN and in dB, GAIN(DB).

[5] Pattern Distribution

When a horizontal pattern is requested, the user has the option of requesting the calculation of the pattern distribution. This is a plot of the levels which are exceeded for specified percentiles of the 360° azimuth.

[6] Feed/Load

In the SIMPLE PROGRAM only one antenna can be fed at a time and no loads are allowed in the other antennas which are assumed terminated by their nominal input impedances (50 ohms). In the GENERAL PROGRAM, all antennas may be fed and can also carry one load each. This will allow the solution of more general problems such as antenna arrays or special types of antennas not included in the simplified program catalog.

[7] Communication Range Contours

The program will also compute communication range contours for specified signal levels for up to six different airplane heights above the ground. The ranges are expressed in nautical miles. The description of the obstacles around the antenna farm has been computed by the SCREEN PROGRAM, and is stored in a file whose name has to be entered by the user upon requesting communication range contour calculations. Communication range contours cannot be computed by the GENERAL PROGRAM.

2.6 Program Limitations

The primary limitations of the program as listed in the Appendix are shown below.

a) Maximum number of runs 10

b) Maximum number of antennas in the General Program 200

c) Maximum number of antennas in the SIMPLE PROGRAM 20

Maximum number of sub-antennas to represent antennas in the SIMPLE PROGRAM 200

Number of sub-antennas used to represent each antenna in the SIMPLE PROGRAM

AT 1181 - 1
AT 1097 - 5
AT 1000 - 1
AT 197 - 26

d) Maximum number of segments to represent the current on all antennas 500

e) Number of segments used to represent each antenna in the SIMPLE PROGRAM

f > 200 MHz (UHF)

with mutual coupling calculations	AT 197 -	7 if fed
		51 if not fed
	At 1097 -	29
	AT 1181 -	16
Without mutual coupling calculations	AT 197 -	7 if fed
		39 if not fed
	AT 1097 -	29 if fed
		20 if not fed
	AT 1181 -	12

f $\leq$ 200 MHz (VHF)

with mutual coupling calculations	AT 197 -	39
	AT 1097 -	21
	AT 1181 -	12
Without mutual coupling calculations	AT 197 -	26
	AT 1097 -	13
	AT 1181 -	12 if fed
		7 if not fed

The maximum number of the segments per wavelength used for the AT 1000 are nine in UHF and twelve in VHF.

3. SAMPLE RUNS

In this section we will present four examples of use of the DISTORT program.

In the printouts that follow, CR means a carriage return entered by the user. Numbers on the left-hand side margin are references to explanations that follow the run. All user responses are underlined.

The answers to the terminal questions are either numbers or words such as YES, NO, INCHES, METERS, etc. Whenever this last type of answer is requested, the user can type the whole word or just the first letter. In any event, the computer recognizes only the first letter. Therefore, Y, YES, YNO are all interpreted as YES since the first letter is a Y. No blanks are allowed before the word. For example _YES (where _ is a blank) will be detected as an error and the question will be repeated again after the message: "....INPUT ERROR, TRY AGAIN...." is typed in the terminal.

The computer does not take any answer until a carriage return (CR) is entered. Therefore, if an input error is detected before the CR, two procedures can be used to correct it [1]:

(a) If the whole line is to be deleted, press simultaneously the CTRL and X keys. The computer will print DEL indicating that the whole entry has been deleted and skips to the next line waiting for the

[1] For more detailed information, see GE-600 Line GECOS III Time-Sharing FORTRAN, manual #CPB-1566A, now Honeywell BR 70.

line to be re-entered.

EX:

ANTENNA POSITION X Y Z

= 100,10, DEL

10,10,0 CR

(b) If only a few characters have to be corrected, press SHIFT and @ as many times as there are characters to be corrected.

EX:

ABD@CD is read as ABCD

AB_C@@CD is read as ABCD

N@Y is read as Y

3.1.1 EXAMPLE 1 - In this example many errors were introduced on purpose to exercise as much as possible the error detection capability of the program.

CR

```
0110401

RADC R&D TSS GCOS-SRH 03/08/78 AT 11.727 CHANNEL 2570

LOGON ID-BLA00001;956700160121
1 PASSWORD--
[redacted]
4 BLOCKS FILE SPACE AVAILABLE

2 SYSTEM ?FORT NEW
READY
*RUN AFCS.LIB/RADIO/DISTORT

3 DIMENSIONS IN METERS OR INCHES ?
=N
4 ..... INPUT ERROR, TRY AGAIN .....
5 DIMENSIONS IN METERS OR INCHES ?
= M
6 ..... INPUT ERROR, TRY AGAIN .....
7 DIMENSIONS IN METERS OR INCHES ?
=M
8 GROUND PLANE ?
=YES
SIMPLE PROG ?
=Y
COUPLING COEFFICIENTS ?
=N
NUMBER OF ANTENNAS
=4
**** ANTENNA NUMBER 1 ****
9 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1197
..... INPUT ERROR, TRY AGAIN .....
10 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1097
11 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=1., DEL
0.,0.,0.
**** ANTENNA NUMBER 2 ****
ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1182
12 ..... INPUT ERROR, TRY AGAIN .....
13 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1183@1
ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,1.,0.
**** ANTENNA NUMBER 3 ****
ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1000
LENGTH
=2.
DIAMETER
=0.009
ANTENNA POSITION X,Y,Z ON THE PLATFORM
```

```
=1.,0.,0.
**** ANTENNA NUMBER  4  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=197
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=-1.,0.,0.
+++ RADIATION PATTERN +++
 VERTICAL PATTERN ?
=N
 HORIZONTAL PATTERN ?
=N
 COMMUNICATION RANGE CONTOUR ?
=NO

14   ..... INPUT ERROR, TRY AGAIN .....
 VERTICAL PATTERN ?
=N
 HORIZONTAL PATTERN ?
=Y
 THETA (DEGREES)
=90
15   90

FILE CODE 41 ILLEGAL CHAR; CORRECTION =0
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=.0.

16   ..... INPUT ERROR, TRY AGAIN .....

 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.

 PATTERN DISTRIBUTION ?
=N
 COMMUNICATION RANGE CONTOUR ?
=N

 NUMBER OF RUNS
=1
**** RUN #  1 ****
 FREQUENCY (MHZ)
=127
17   FED ANTENNA (#)
=5
..... INPUT ERROR, TRY AGAIN .....
18   FED ANTENNA (#)
=1
..... INPUT ERROR, TRY AGAIN .....
 FREQUENCY (MHZ)
=127
19   FED ANTENNA (#)
=3
..... INPUT ERROR, TRY AGAIN .....
 FED ANTENNA (#)
=2
```

```
20    DIM= M  GP= Y  SIMP= Y  COUPL= N  NR=  4
      ANT# =      1        2        3        4
      TYPE =    1097     1181     1000      197
      X    =  0.       0.       1.000   -1.000
      Y    =  0.       1.000    0.       0.
      Z    =  0.       0.       0.       0.
      L    =  0.       0.       2.000    0.
      D    =  0.       0.       0.009    0.
      VER PAT=  N
      HOR PAT=  Y
      THETA=  90.0  PLOT INC=  10.00
      PAT DIST= N
      COM RNG=  N

      RUN#      FREQ(MHZ)   ANT FED(#)
        1        127.00        2
21    DATA CORRECT?
      =Y

22    PROGRAM EXECUTION NUMBER-7832
23    ARRAY DIMENSIONS = 61
24    JOB REQUIRES 50/100 HR TIME AND 035K WORDS CORE.

25       SNUMB # 2127t
26     RERUN?
       =N

27     SYSTEM ?JSTS 2127T
28     2127T -01    WAIT CORE
29     SYSTEM ? BYE

         2 TEMPORARY FILES CREATED.

       01        ?          CR

       02        ?          CR
      **cost:   $    0.16 to date:  $ 3243.14= 65%
       **on at 11.727 - off at 11.749 on  03/08/78
```

SNUMB = 2127I, ACTIVITY # = 01, , REPORT CODE = 06, RECORD COUNT = 00C049

*** ANT# (FED)= 2 FREQ (MHZ)= 127.00 ***

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 1.209 GAIN= 9.762 GAIN(DB)= 9.90

PHI	NMAG	NMAG(DB)
0.	0.7331	-2.70
10.	0.5933	-4.53
20.	0.4618	-6.71
30.	0.3669	-8.71
40.	0.3319	-9.58
50.	0.3484	-9.16
60.	0.3839	-8.32
70.	0.4179	-7.58
80.	0.4491	-6.95
90.	0.4843	-6.30
100.	0.5260	-5.58
110.	0.5643	-4.97
120.	0.5816	-4.71
130.	0.5642	-4.97
140.	0.5154	-5.76
150.	0.4656	-6.64
160.	0.4665	-6.62
170.	0.5397	-5.36
180.	0.6497	-3.75
190.	0.7522	-2.47
200.	0.8218	-1.70
210.	0.8503	-1.41
220.	0.8412	-1.50
230.	0.8046	-1.89
240.	0.7532	-2.46
250.	0.7010	-3.09
260.	0.6627	-3.57
270.	0.6546	-3.68
280.	0.6890	-3.24
290.	0.7634	-2.34
300.	0.8577	-1.33
310.	0.9436	-0.50
320.	0.9961	-0.03
330.	1.0000	0.
340.	0.9520	-0.43
350.	0.8586	-1.32
360.	0.7331	-2.70

3.1.2 Explanation of Example 1

1. Sign on procedure - the user enters his USER ID and PASSWORD (masked on purpose). After any entry, always enter a CR to indicate that the input line is completed.
2. Request the system /RADIO/DISTORT to be run from the AFCS.LIB user library
3. The answer to "DIMENSIONS IN METERS OF INCHES" has to be any of the following, M, METERS, I, INCHES. In this case, N was inadvertently entered.
4. The program does not recognize the answer and requests that the information be entered again.
5. Note that the computer repeats the question.
6. Again, inadvertently, a blank was entered before M and the computer rejects the input again.
7. Finally, the correct input is entered.
8. Note that YES and Y are acceptable answers.
9. A mistake in the antenna type is made.
10. The correct answer is entered.
11. In this case the user detected an error (1., instead of zero was entered) and the input was cancelled by depressing simultaneously the keys CTRL and X. The computer prints DEL indicating that the information was deleted, skips to the next line and waits for the line to be typed over.
12. Again an input error is detected by the computer.
13. This is an example of how to correct only a few characters. The 3 was replaced by the 1 entered after the @.

14. This message is issued because this run has no output since NO COUPLING COEFFICIENTS were requested at the beginning and NO VERTICAL, HORIZONTAL PATTERNS or COMMUNICATION RANGE CONTOUR were requested now. At least one of these four answers has to be YES. Note that the computer asks the questions again.

15. A common mistake is to type the letter "O" instead of zero (Ø). The computer detected that 90 was entered instead of 9Ø.

16. The plotting increment has to be a non-zero number; thus, the next two error messages.

17. The antenna specified does not exist since we have only four antennas.

18. Antenna 1 is UHF and the frequency specified is VHF, so the question FREQUENCY and FED ANTENNA are repeated.

19. Antenna 3 is a lightning rod and therefore cannot be fed.

20. This is a printout of what was just read for the user's verification. Take a moment to double check this, other-wise the whole run may be wasted. Note that the type of ANTENNA NUMBER 2 has been corrected to 1181. DIM = M means dimensions in meters. The other answers are self explanatory.

21. If the answer is "N", the computer will go to step 26.

22. This is the needed information to run the plotter program /RADIO/DISTORTP.

23. The minimum array sizes of C1, C2 are (61 x 61).

24. This says that the job requires 50 hundreds of one hour to run and 100K of memory.

25. The CARDIN system will assign a number to this specific run. In this case 2127T

26. If the answer is "Y", the computer will go to step 3 and start a new run. If "N" is entered, the computer goes back to system level.

27. This is a request of the status of your job. JSTS 2127T means what is the JOB STATUS of 2127T.

28. In this case, the answer was that the program STATUS was waiting for core to be allocated. If the job is small, it is possible that it will be run after a short time and therefore you may wish to keep the terminal on. Periodically, request your job status, or use the terminal for other jobs, otherwise you will be disconnected by the computer after 10 minutes of inactivity.

29. BYE is the message to disconnect the terminal. If at a later time the user requests the job status and the computer replies that the job is completed with NORMAL TERMINATION, it means that the run was successful and the output is ready in file /DISTRT/7832 for use by the plotter program.

30. The output will also be printed out on the high speed printer at the central site under the #2127T as shown here. Note that the angle PHI is measured clockwise from the x-axis to conform with the azimuths of SCREEN (see Figs. 1, 2). Note also that the magnitude of the radiation pattern is listed in ratio as well as in dB normalized to EMAX, its maximum magnitude. The gain over the isotropic source in the direction of EMAX is also given in ratio and in dB.

3.2.1 Example 2 - In this example the use of multiple runs and outputs with mutual couplings and pattern distribution are illustrated.

```
SYSTEM ?FORT NEW
READY
*RUN AFCS.LIB/RADIO/DISTORT

 DIMENSIONS IN METERS OR INCHES ?
=I
 GROUND PLANE ?
=N
 SIMPLE PROG ?
=Y
1  COUPLING COEFFICIENTS ?
=Y
 NUMBER OF ANTENNAS
=3
**** ANTENNA NUMBER  1  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1181
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,36.,0.
**** ANTENNA NUMBER  2  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1097
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,0.,0.
**** ANTENNA NUMBER  3  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1[illegible]
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=-36.,0.,0.
+++ RADIATION PATTERN +++
 VERTICAL PATTERN ?
=Y
 PHI (DEGREES)
=0.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
 HORIZONTAL PATTERN ?
=Y
 THETA (DEGREES)
=90.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=15.
2  PATTERN DISTRIBUTION ?
=Y
 PLOT IN MAG, DB, OR BOTH ?
=M
 PERCENT INCREMENT
=20
 COMMUNICATION RANGE CONTOUR ?
=N
```

```
3    NUMBER OF RUNS
    =2
4   **** RUN #  1 ****
     FREQUENCY (MHZ)
    =118.5
     FED ANTENNA (#)
    =1
    **** RUN #  2 ****
     FREQUENCY (MHZ)
    =400,
     FED ANTENNA (#)
    =3


    DIM=  I  GP= N   SIMP= Y   COUPL= Y   NR=  3
    ANT# =       1          2          3
    TYPE =     1181      1097        197
    X    =    0.         0.       -36.000
    Y    =   36.000      0.         0.
    Z    =    0.         0.         0.
    VER PAT=   Y
    PHI   =    0.    PLOT INC=  10.00
    HOR PAT=   Y
    THETA=   90.0   PLOT INC=  15.00
    PAT DIST= Y
    PLOT= M   INC=   20.0 %
    COM RNG=   N


    RUN#       FREQ(MHZ)   ANT FED(#)
      1         118.50         1
      2         400.00         3
    DATA CORRECT ?
    =Y
    PROGRAM EXECUTION NUMBER-7830
    ARRAY DIMENSIONS = 72
    JOB REQUIRES 50/100 HR TIME AND 038K WORDS CORE.
      SNUMB # 2122t
    RERUN?
    =N


    SYSTEM ?
```

SNUMB = 2122T, ACTIVITY # = 01, REPORT CODE = 06, RECORD COUNT = 000168

*** ANT# (FED)= 1 FREQ (MHZ)= 118.50 ***

5 COUPLING COEFFICIENT

ANTENNA NO.	POWER RECEIVED (DB)
2	-17.06
3	-32.92

VERTICAL PATTERN

PHI= 0.

EMAX= 0.613 GAIN= 1.368 GAIN(DB)= 1.36

THETA	NMAG	NMAG(DB)
0.	0.0082	-41.71
10.	0.1150	-18.78
20.	0.2434	-12.27
30.	0.3749	-8.52
40.	0.5042	-5.95
50.	0.6253	-4.08
60.	0.7341	-2.69
70.	0.8300	-1.62
80.	0.9126	-0.79
90.	0.9743	-0.23
100.	1.0000	0.
110.	0.9763	-0.21
120.	0.9012	-0.90
130.	0.7844	-2.11
140.	0.6412	-3.86
150.	0.4851	-6.28
160.	0.3253	-9.75
170.	0.1657	-15.61
180.	0.0085	-41.43

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.772 GAIN= 2.167 GAIN(DB)= 3.36

PHI	NMAG	NMAG(DB)
0.	0.7739	-2.23
15.	0.7606	-2.38
30.	0.7790	-2.17
45.	0.8143	-1.78
60.	0.8548	-1.36
75.	0.8923	-0.99
90.	0.9170	-0.75
105.	0.9208	-0.72
120.	0.9002	-0.91
135.	0.8572	-1.34
150.	0.8022	-1.91

165.	0.7575	-2.41
180.	0.7479	-2.52
195.	0.7810	-2.15
210.	0.8411	-1.50
225.	0.9057	-0.86
240.	0.9581	-0.37
255.	0.9895	-0.09
270.	1.0000	0.
285.	0.9939	-0.05
300.	0.9736	-0.23
315.	0.9368	-0.57
330.	0.8826	-1.08
345.	0.8210	-1.71
360.	0.7739	-2.23

6 PATTERN DISTRIBUTION

%	MAG
0.	1.000
10.0	0.985
20.0	0.945
30.0	0.917
40.0	0.899
50.0	0.870
60.0	0.844
70.0	0.813
80.0	0.780
90.0	0.765
100.0	0.748

7 *** ANT# (FED)= 3 FREQ (MHZ)= 400.00 ***

COUPLING COEFFICIENT

ANTENNA NO.	POWER RECEIVED (DB)
1	-31.44
2	-16.96

VERTICAL PATTERN

PHI= 0.

EMAX= 0.777 GAIN= 2.518 GAIN(DB)= 4.01

THETA	NMAG	NMAG(DB)
0.	0.0000	-1000.00
10.	0.0672	-23.45
20.	0.1774	-15.02
30.	0.3170	-9.98
40.	0.4315	-7.30
50.	0.5137	-5.79
60.	0.6163	-4.20
70.	0.7047	-3.04
80.	0.8325	-1.59
90.	0.9327	-0.60

100.	1.0000	0.
110.	0.9852	-0.13
120.	0.8566	-1.34
130.	0.7798	-2.16
140.	0.7083	-3.00
150.	0.5776	-4.77
160.	0.4294	-7.34
170.	0.2315	-12.71
180.	0.0000	-1000.00

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.974 GAIN= 3.952 GAIN(DB)= 5.97

PHI	NMAG	NMAG(DB)
0.	0.7445	-2.56
15.	0.7127	-2.94
30.	0.3160	-10.01
45.	0.8222	-1.70
60.	0.7132	-2.94
75.	1.0000	0.
90.	0.3679	-8.68
105.	0.7326	-2.70
120.	0.8556	-1.35
135.	0.5671	-4.93
150.	0.6507	-3.73
165.	0.5871	-4.63
180.	0.6301	-4.01
195.	0.9781	-0.19
210.	0.3116	-10.13
225.	0.7431	-2.58
240.	0.6811	-3.34
255.	0.9196	-0.73
270.	0.6721	-3.45
285.	0.5178	-5.72
300.	0.7171	-2.89
315.	0.4108	-7.73
330.	0.2177	-13.24
345.	0.2814	-11.01
360.	0.7445	-2.56

PATTERN DISTRIBUTION

%	MAG
0.	1.000
10.0	0.900
20.0	0.776
30.0	0.734
40.0	0.713
50.0	0.677
60.0	0.634
70.0	0.562
80.0	0.394
90.0	0.313
100.0	0.218

3.2.2. Explanation of Example 2

1. Note that the coupling coefficients have been requested.
2. Note that the pattern distribution is also requested.
3. Note the specification of two runs.
4. For every run the number of the fed antenna, as well as the frequency, is requested.
5. The mutual coupling coefficient is defined as the ratio of the received power at any specified antenna (terminated by 50Ω in the SIMPLE PROGRAM) to the input power of the fed antenna.
6. This is the listing of pattern distribution.
7. This is the beginning of the output listing for the second run.

3.3.1 EXAMPLE 3 - This example illustrates the use of the general program option. Note the detailed input information required.

```
SYSTEM ?FORT NEW
READY
*RUN AFCS.LIB/RADIO/DISTORT
 DIMENSIONS IN METERS OR INCHES ?
=M
 GROUND PLANE ?
=N
1  SIMPLE PROG ?
=N
 FREQUENCY (MHZ)
=125.
 NUMBER OF ANTENNAS
=3
2  AUTO SPEC #SEGS ?
=Y
**** ANTENNA NUMBER 1 ****
 ANTENNA LENGTH
=1.
3  LOAD POSITION
=0
 FEED POSITION
=0.5
4  ANTENNA RADIUS
=.3
..... INPUT ERROR, TRY AGAIN .....
 ANTENNA RADIUS
=.02
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,0.,0.
5  FEED VOLTAGE (REAL,IMAG)
=1.,0.
 LOAD IMPEDANCE (REAL,IMAG)
6  =0,0
**** ANTENNA NUMBER 2 ****
 ANTENNA LENGTH
=1.5
 LOAD POSITION
=1.
 FEED POSITION
=0.
 ANTENNA RADIUS
=0.03
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=1.,0.,0.
 FEED VOLTAGE (REAL,IMAG)
=0.,0.
7  LOAD IMPEDANCE (REAL,IMAG)
=50.,0.
**** ANTENNA NUMBER 3 ****
 ANTENNA LENGTH
=1.2
```

```
LOAD POSITION
=0.8
FEED POSITION
=0.
ANTENNA RADIUS
=0.03

ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,1.2,0.3
FEED VOLTAGE (REAL,IMAG)
=0,0
LOAD IMPEDANCE (REAL,IMAG)
=72.,0.
+++ RADIATION PATTERN +++
VERTICAL PATTERN ?
=YES
PHI (DEGREES)
=90.
PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
HORIZONTAL PATTERN ?
=Y
THETA (DEGREES)
=90.
PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
PATTERN DISTRIBUTION ?
=N


DIM= M  GP= N  AUTO= Y  FREQ=  125.00  NR=  3
ANT# =     1        2        3
L    =   1.000    1.500    1.200
LP   =   0.       1.000    0.800
FP   =   0.500    0.       0.
R    = 0.02000  0.03000  0.03000
X    =   0.       1.000    0.
Y    =   0.       0.       1.200
Z    =   0.       0.       0.300
RE V =   1.000    0.       0.
IM V =   0.       0.       0.
RE LD=     0.      50.0     72.0
IM LD=     0.       0.       0.
VER PAT=  Y
PHI  =  90.0  PLOT INC=  10.00
HOR PAT=  Y
THETA=  90.0  PLOT INC=  10.00
PAT DIST= N
DATA CORRECT ?
=Y
```

PROGRAM EXECUTION NUMBER--7831
ARRAY DIMENSIONS = 14
JOB REQUIRES 50/100 HR TIME AND 028K WORDS CORE.

SNUMB # 2146T

RERUN?
=N

SNUMB = 2146T, ACTIVITY # = 01, REPORT CODE = 06, RECORD COUNT = 000074

VERTICAL PATTERN

PHI= 90.0

EMAX= 0.588 GAIN= 1.527 GAIN(DB)= 1.84

THETA	NMAG	NMAG(DB)
0.	0.	-1000.00
10.	0.1658	-15.61
20.	0.3625	-8.81
30.	0.5646	-4.97
40.	0.7417	-2.60
50.	0.8717	-1.19
60.	0.9499	-0.45
70.	0.9875	-0.11
80.	1.0000	0.
90.	0.9950	-0.04
100.	0.9701	-0.26
110.	0.9209	-0.72
120.	0.8483	-1.43
130.	0.7568	-2.42
140.	0.6495	-3.75
150.	0.5238	-5.62
160.	0.3737	-8.55
170.	0.1969	-14.12
180.	0.0000	-1000.00

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.760 GAIN= 2.553 GAIN(DB)= 4.07

PHI	NMAG	NMAG(DB)
0.	0.6146	-4.23
10.	0.6752	-3.41
20.	0.6888	-3.24
30.	0.6586	-3.63
40.	0.6044	-4.37
50.	0.5593	-5.05
60.	0.5569	-5.08
70.	0.6057	-4.35
80.	0.6852	-3.28
90.	0.7696	-2.27
100.	0.8440	-1.47

110.	0.9049	-0.87
120.	0.9528	-0.42
130.	0.9862	-0.12
140.	1.0000	0.
150.	0.9884	-0.10
160.	0.9482	-0.46
170.	0.8803	-1.11
180.	0.7912	-2.03
190.	0.6968	-3.14
200.	0.6257	-4.07
210.	0.6089	-4.31
220.	0.6522	-3.71
230.	0.7273	-2.77
240.	0.7975	-1.96
250.	0.8358	-1.56
260.	0.8275	-1.65
270.	0.7696	-2.27
280.	0.6706	-3.47
290.	0.5493	-5.20
300.	0.4320	-7.29
310.	0.3458	-9.22
320.	0.3123	-10.11
330.	0.3401	-9.37
340.	0.4183	-7.57
350.	0.5203	-5.68
360.	0.6146	-4.23

PATTERN DISTRIBUTION

%	MAG
0.	1.000
10.0	0.950
20.0	0.844
30.0	0.794
40.0	0.727
50.0	0.680
60.0	0.652
70.0	0.607
80.0	0.557
90.0	0.425
100.0	0.312

3.3.2 Explanation of Example 3

1. Note this is an example of the use of the GENERAL PROGRAM.
2. Each antenna is divided in a certain number of segments over which the current is assumed constant. When the answer to AUTO SPEC # SEGS? is YES, the computer uses 15 segments per wavelength for the fed antennas and between 6 to 10 per wavelength for the others depending on how far they are from the fed antenna. If the answer is NO, then the actual number of segments for each antenna has to be specified by the user.
3. When there is no load on the antenna, enter Ø here.
4. The maximum radius permissible is .1λ, thus the error message.
5. This indicates that this is the fed antenna. Other antennas can also be fed simultaneously in this version of the program. Therefore, the radiation pattern of an array of antennas can be calculated.
6. As this antenna has no load, enter Ø.,Ø. here. If there were a load, then the real and imaginary parts of the load impedance (in ohms) should be entered here.
7. This is the real and imaginary parts of the load in ohms.

3.4.1 EXAMPLE 4 - This example illustrates the use of the communication range contour program option.

```
SYSTEM ?FORT NEW
READY
*RUN AFCS.LIB/RADIO/DISTORT

 DIMENSIONS IN METERS OR INCHES ?
=M
 GROUND PLANE ?
=N
 SIMPLE PROG ?
=Y
 COUPLING COEFFICIENTS ?
=N
 NUMBER OF ANTENNAS
=1
**** ANTENNA NUMBER  1  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=197
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,0.,0.
+++ RADIATION PATTERN +++
 VERTICAL PATTERN ?
=Y
 PHI (DEGREES)
=0.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
 HORIZONTAL PATTERN ?
=N
1 COMMUNICATION RANGE CONTOUR ?
=Y
2 NAME OF SCREEN FILE
=DATAFILE
3 RECEIVER SENSITIVITY (DBM)
=-80.
 GROUND TRANSMITTER POWER (WATT)
=10.

+++++ ENTER SITE PARAMETERS +++++

 GROUND ELEVATION IN FEET
=6546.
 TRANSIT ELEVATION IN FEET
=6568.
 ANTENNA ELEVATION IN FEET
=6586.
4 ANTENNA OFFSET FROM TRANSIT ?
=Y
 ENTER DISTANCE TO ANTENNA IN FEET
=0.
```

```
5     BEARING TO ANTENNA IN DEG AND MIN (DD.MM)
     =0.0
6     STANDARD ALTITUDES ?
     =N
      NUMBER OF ALTITUDES TO BE CALCULATED (1-6)
     =6
      DESIRED ALTITUDES IN FEET
     =1000.,5000.,10000.,15000.,20000.,35000.

      GROUND  ELEV =  6546.0 FT
      TRANSIT ELEV =  6568.0 FT
      ANTENNA ELEV =  6586.0 FT
7     DIST TO ANT (FT)   =      0.
      BEAR TO ANT(DD.MM)=       0.
      AIRCRAFT ALT'S ARE IN FT AGL.
      ALT'S=  1000.0  5000.0 10000.0 15000.0 20000.0 35000.0

      NUMBER OF RUNS
     =1
     **** RUN #  1 ****
      FREQUENCY (MHZ)
     =320.
      FED ANTENNA (#)
     =1


     DIM= M  GP= N  SIMP= Y  COUPL= N  NR=  1
     ANT# =      1
     TYPE =      197
     X    =   0.
     Y    =   0.
     Z    =   0.
     VER PAT=  Y
     PHI   =   0.    PLOT INC=  10.00
     HOR PAT= N
     COM RNG=  Y
     REC SEN (DBM)=  -80.0 GROUND TPW (WATT)=  10.0

     RUN#      FREQ(MHZ)  ANT FED(#)
       1        320.00        1
     DATA CORRECT ?
     =Y
     PROGRAM EXECUTION NUMBER-78
     ARRAY DIMENSIONS =  7
     JOB REQUIRES 50/100 HR TIME AND 028K WORDS CORE.
       SNUMB # 7952t
     RERUN?
     =N
```

SNUMB = 7952T, ACTIVITY # = 01, , REPORT CODE = Q6, RECORD COUNT = 000172

*** ANT# (FED)= 1 FREQ (MHZ)= 320.00 ***

RECEIVER SENSITIVITY (DBM)= -80.0
TRANSMITTER POWER (WATT) = 10.0

VERTICAL PATTERN

PHI= 0.

EMAX= 24.555 GAIN= 2.010 GAIN(DB)= 3.03

THETA	NMAG	NMAG(DB)
0.	0.0000	-1000.00
10.	0.1510	-16.42
20.	0.3000	-10.46
30.	0.4443	-7.05
40.	0.5803	-4.73
50.	0.7032	-3.06
60.	0.8084	-1.85
70.	0.8923	-0.99
80.	0.9527	-0.42
90.	0.9888	-0.10
100.	1.0000	0.
110.	0.9843	-0.14
120.	0.9384	-0.55
130.	0.8590	-1.32
140.	0.7439	-2.57
150.	0.5943	-4.52
160.	0.4147	-7.64
170.	0.2132	-13.43
180.	0.0000	-1000.00

8 COMMUNICATION RANGE CONTOUR

ALT(FT)	1000.0	5000.0	10000.0	15000.0	20000.0	35000.0
PHI(DEG)		RANGE(NM)				
0.	6.2	29.2	53.5	56.2	56.1	55.9
6.50	5.3	25.5	47.7	56.1	56.1	55.9
10.50	5.7	27.1	50.1	56.2	56.1	55.9
20.00	5.9	28.0	51.7	56.2	56.1	55.9
30.00	8.5	37.6	56.3	56.2	56.2	56.0
31.32	5.4	25.9	48.3	56.1	56.1	55.9
35.37	5.2	25.1	46.9	56.1	56.1	55.9
40.00	6.2	29.1	53.4	56.2	56.1	55.9
50.00	6.2	29.1	53.4	56.2	56.1	55.9
60.00	5.9	27.8	51.3	56.2	56.1	55.9
65.20	4.7	23.0	43.4	56.1	56.1	55.8
70.00	6.2	29.1	53.4	56.2	56.1	55.9
75.67	6.0	28.3	52.1	56.2	56.1	55.9

85.00	7.9	35.6	56.3	56.2	56.2	56.0
90.00	6.9	32.0	56.2	56.2	56.2	55.9
116.00	13.7	52.0	56.3	56.3	56.3	56.1
123.33	16.6	55.4	56.4	56.3	56.3	56.1
148.00	45.6	56.5	56.4	56.4	56.4	56.1
155.00	30.1	56.4	56.4	56.4	56.3	56.1
159.15	25.5	56.4	56.4	56.4	56.3	56.1
159.75	39.8	56.5	56.4	56.4	56.3	56.1
162.00	56.0	56.5	56.4	56.4	56.4	56.2
163.07	41.9	56.5	56.4	56.4	56.4	56.1
163.78	56.5	56.5	56.5	56.4	56.4	56.2
166.50	56.5	56.5	56.5	56.4	56.4	56.2
171.95	9.2	39.9	56.3	56.3	56.2	56.0
173.00	6.6	30.9	56.2	56.2	56.2	55.9
173.73	5.1	24.7	46.3	56.1	56.1	55.9
174.12	5.4	25.8	48.0	56.1	56.1	55.9
175.30	4.6	22.5	42.6	56.1	56.1	55.8
176.95	5.5	26.4	49.1	56.2	56.1	55.9
177.22	4.9	23.7	44.7	56.1	56.1	55.9
177.50	5.1	24.5	46.0	56.1	56.1	55.9
178.33	4.7	22.8	43.2	56.1	56.1	55.8
179.23	5.9	27.9	51.4	56.2	56.1	55.9
179.68	5.4	26.0	48.4	56.2	56.1	55.9
180.27	5.7	27.1	50.3	56.2	56.1	55.9
180.57	5.6	26.7	49.5	56.2	56.1	55.9
182.12	5.2	25.1	47.0	56.1	56.1	55.9
182.38	5.4	25.8	48.0	56.1	56.1	55.9
182.67	5.2	25.1	47.0	56.1	56.1	55.9
183.50	5.6	26.7	49.5	56.2	56.1	55.9
184.02	4.9	23.9	45.0	56.1	56.1	55.9
184.82	4.5	22.2	42.1	56.1	56.0	55.8
186.50	4.1	20.4	38.9	56.0	56.0	55.8
187.92	4.3	21.1	40.2	56.1	56.0	55.8
191.35	2.9	14.8	28.9	42.3	55.1	55.6
192.90	3.4	17.1	33.2	48.3	55.9	55.7
199.08	2.6	13.0	25.5	37.5	49.1	55.6
200.28	2.5	12.7	24.9	36.7	48.1	55.5
203.78	2.3	11.8	23.3	34.5	45.2	55.5
205.73	3.0	15.2	29.6	43.3	55.9	55.7
206.13	3.1	15.4	30.0	43.9	55.9	55.7
206.73	2.9	14.4	28.2	41.3	53.9	55.6
207.32	2.9	14.8	28.9	42.3	55.1	55.6

208.37	3.0	15.2	29.6	43.3	55.9	55.7
219.18	1.7	8.9	17.7	26.3	34.8	55.2
221.42	1.9	9.8	19.5	28.9	38.2	55.3
222.43	2.0	10.3	20.5	30.3	40.0	55.4
222.72	2.0	10.2	20.2	29.9	39.4	55.4
225.00	2.1	10.8	21.3	31.5	41.5	55.4
226.20	2.0	10.3	20.3	30.1	39.7	55.4
227.50	2.1	10.7	21.2	31.3	41.2	55.4
228.22	2.0	10.4	20.6	30.6	40.2	55.4
235.12	1.7	8.9	17.8	26.4	34.9	55.2
235.12	1.7	8.9	17.8	26.4	34.9	55.2
235.80	1.8	9.1	18.2	27.0	35.7	55.3
238.23	1.7	8.7	17.2	25.6	33.9	55.2
239.85	1.7	8.9	17.7	26.3	34.8	55.2
240.67	1.6	8.2	16.4	24.4	32.3	55.1
244.10	1.5	7.8	15.4	23.0	30.5	52.3
244.77	1.6	8.1	16.1	24.0	31.7	54.3
246.33	1.9	9.9	19.7	29.2	38.5	55.3
254.47	2.6	13.2	25.9	38.1	49.9	55.6
254.47	2.6	13.2	25.9	38.1	49.9	55.6
254.60	2.5	12.5	24.6	36.3	47.5	55.5
257.18	2.0	10.4	20.6	30.5	40.2	55.4
267.00	2.1	10.5	20.9	30.9	40.7	55.4
271.00	1.7	8.5	17.0	25.3	33.4	55.2
272.77	1.8	9.5	18.8	27.9	36.8	55.3
275.00	2.1	10.5	20.8	30.8	40.6	55.4
275.43	2.1	10.7	21.3	31.5	41.4	55.4
276.00	2.0	10.2	20.1	29.9	39.4	55.4
279.00	2.1	10.5	20.9	30.9	40.7	55.4
288.30	2.7	13.5	26.6	39.0	51.0	55.6
289.08	2.5	12.9	25.3	37.2	48.8	55.6
294.85	3.4	16.9	32.7	47.6	55.9	55.7
295.83	3.3	16.5	32.0	46.6	55.9	55.7
296.67	3.5	17.6	34.0	49.3	56.0	55.7
302.10	3.9	19.3	37.1	53.5	56.0	55.8
303.40	4.0	19.7	37.8	54.4	56.0	55.8
303.40	4.0	19.7	37.8	54.4	56.0	55.8
306.78	3.3	16.6	32.2	46.8	55.9	55.7
309.97	4.3	21.4	40.7	56.1	56.0	55.8
311.67	5.6	26.6	49.3	56.2	56.1	55.9
312.87	5.4	26.0	48.5	56.2	56.1	55.9

312.87	5.4	26.0	48.5	56.2	56.1	55.9
317.07	6.6	30.6	55.7	56.2	56.2	55.9
317.58	6.1	28.9	53.0	56.2	56.1	55.9
318.95	6.3	29.7	54.3	56.2	56.1	55.9
320.10	7.7	34.7	56.3	56.2	56.2	56.0
320.30	8.7	38.2	56.3	56.2	56.2	56.0
320.50	8.2	36.4	56.3	56.2	56.2	56.0
321.03	8.5	37.4	56.3	56.2	56.2	56.0
321.70	8.1	36.2	56.3	56.2	56.2	56.0
322.38	9.3	40.0	56.3	56.3	56.2	56.0
327.00	11.2	45.8	56.3	56.3	56.2	56.0
334.53	9.6	41.0	56.3	56.3	56.2	56.0
334.53	9.6	41.0	56.3	56.3	56.2	56.0
336.05	8.4	37.3	56.3	56.2	56.2	56.0
336.05	8.4	37.3	56.3	56.2	56.2	56.0
336.62	7.8	35.0	56.3	56.2	56.2	56.0
338.35	8.4	37.3	56.3	56.2	56.2	56.0
341.00	8.2	36.5	56.3	56.2	56.2	56.0
350.00	7.4	33.8	56.3	56.2	56.2	56.0
350.00	7.4	33.8	56.3	56.2	56.2	56.0

3.4.2 Explanation of Example 4

1. A request for computation of communication range is made.
2. The information about the terrain topography for this site was generated by the program SCREEN and was stored in the file DATAFILE.
3. The program does not include the coaxial cable losses and other losses within the receiver and transmitter. If known, they should be subtracted from the actual receiver sensitivity. For example, if these losses are 10 dB, specify the receiver sensititivty as -70 dB instead of -80 dB.
4. If the answer is YES, the next two questions are asked. If the answer is NO, they are skipped.
5. The bearing is measured from the north, clockwise, and is read in degrees and minutes as DD.MM. Ex: 1.20 = 1°20'.
6. If the answer is NO, the next two questions are asked. If it is YES, they are skipped and the six standard altitudes of 1,000; 5,000; 10,000; 15,000; 20,000; and 35,000 feet above ground level (AGL) are assumed.
7. This is a print out of site parameters which was just read in the computer for user's verification.
8. This is the communication range contour output.

   "Line of Sight Coverage" data of Air Force Academy, Colorado Springs, are stored in the file /RADIO/DATAFILE.

Note: Data in the file DATAFILE have to be stored in the following way in each azimuth direction:

ZZ,ELANG,DIST,RNG(1),...,RNG(6)

. . . . . .

. . . . . .

. . . . . .

where

ZZ = the azimuth angle in radians

ELANG = the angle in radians between the screen top and the ground.

DIST = the distance between the transit and the screen

RNG = up to six lines of sight ranges in nautical miles.

(This has been done by the SCREEN PROGRAM during the file creation.)

Appendix I - Antenna Modeling

Figures 3, 4 and 5 show details of the computer models used by the computer program for the different antennas.

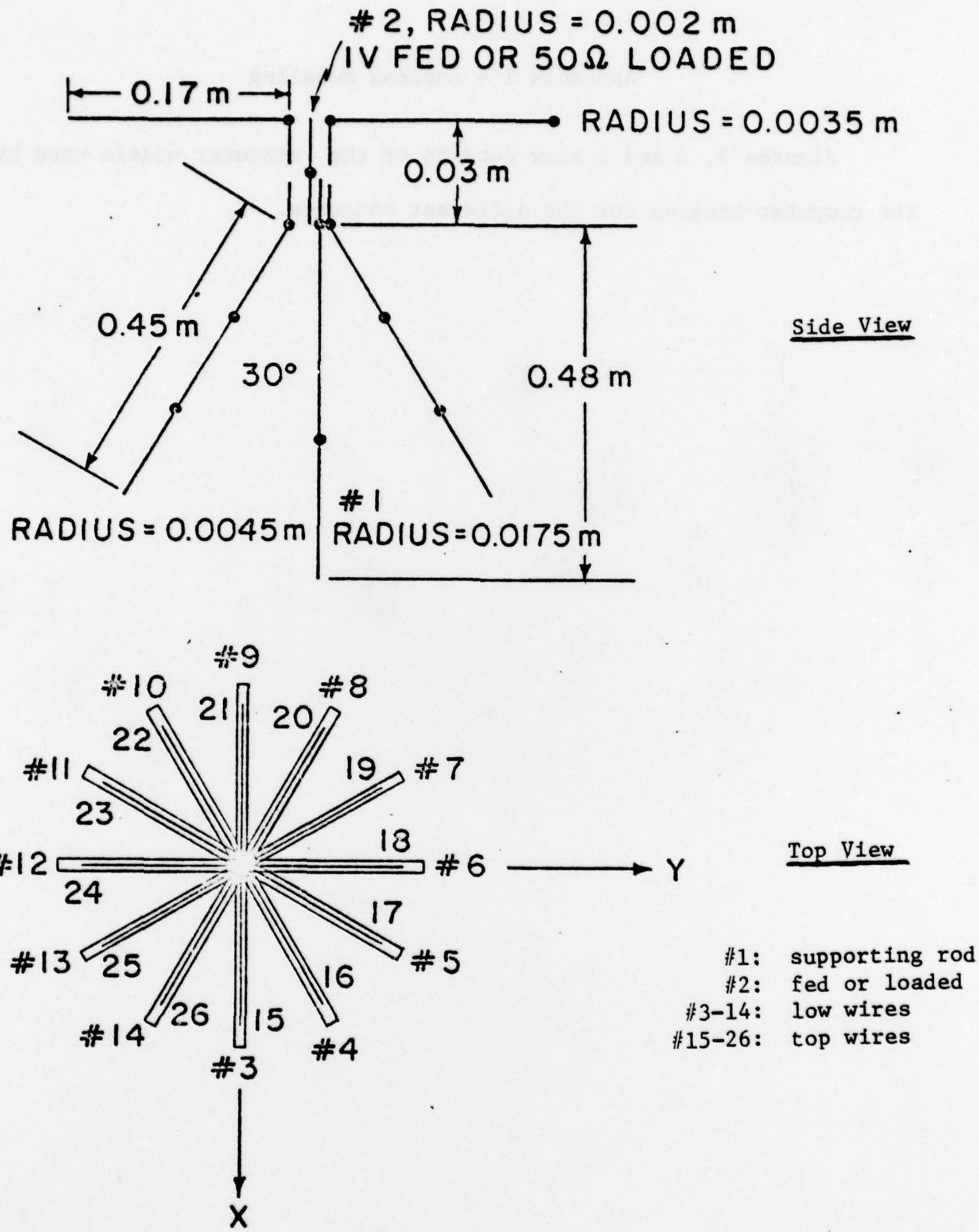
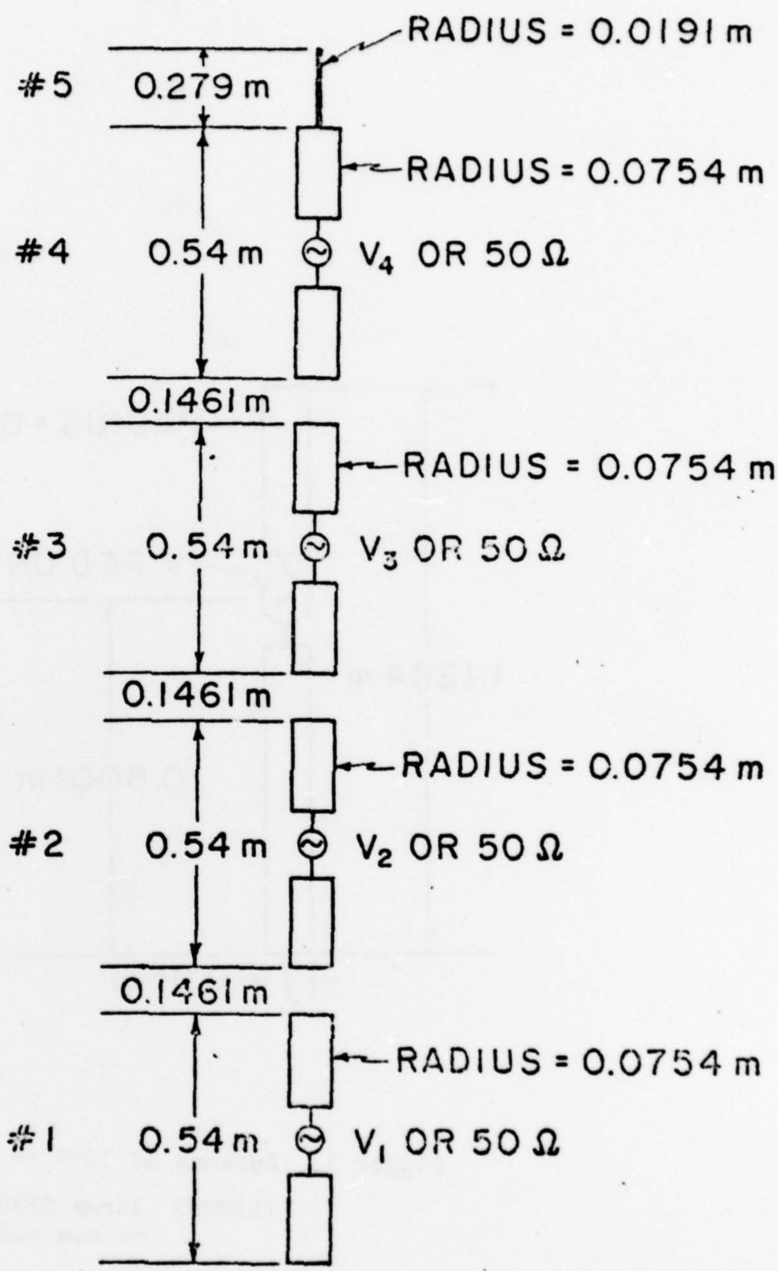


Figure 3. Antenna AT 197 - Subantenna Model
(LINKM3 lines 5520-5580 and PXYZ - see Ref. 1.2b)



$V_1 = 1, \quad V_2 = e^{j\beta_1},$

$V_3 = e^{j2\beta_1}, \quad V_4 = e^{j3\beta_2}$

$\beta_1 = 2\pi \times 0.04166 \times f(\text{MHZ})/(0.6951 \times 300.)$

$\beta_2 = 0.00378094 \times f(\text{MHZ})$

Figure 4. Antenna AT 1181 -- Dimensions Used (LINKM3 line 5860 - see Ref 1.2b)

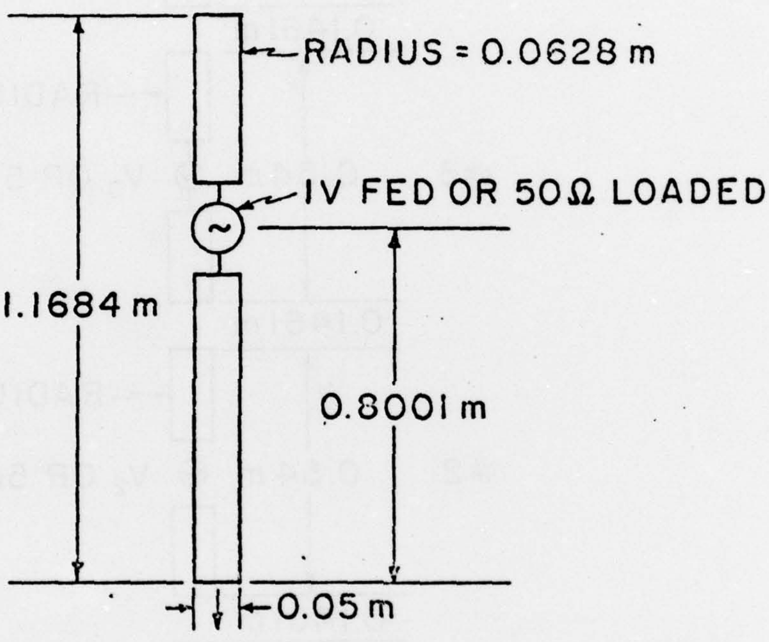


Figure 5. Antenna AT 1097 -- Dimensions Used
(LINKM3 lines 5790-5880 and lines 5930-5970 -- see ref. 1.2b).

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